INDUCTIVE STUDIES IN WEATHER INFLUENCE.[1]

By Prof. EDWIN G. DEXTER, dated the University of Illinois, Urbana, February 2, 1903.

It is my purpose in this paper to outline briefly and state some of the more general conclusions to be drawn from a series of studies which I have made of the influence of definite meteorological conditions upon human conduct. No one who has been at all observant of his own subjective states can doubt that they vary with changes in the weather. Weather proverbs presuppose some direct influence of meteorological conditions upon the lower animals, and literature is full of allusions to similar influences upon man. It was for the purpose of determining this influence, both qualitatively and quantitatively, that my studies were undertaken.

The method followed is a purely inductive one and consists of a comparison of the average daily occurrence of certain recorded abnormalities of conduct, with their occurrence under definite meteorological conditions. The data of conduct considered by me were all taken from the records of New York City, viz, those of the coroner, chief of police, and superintendent of schools, and consisted of the daily record of suicides, both successful and attempted, of arrests for assault and battery and drunkenness, and of deportment in the city penitentiary and certain of the public schools, in all nearly 500,000 separate occurrences covering a period of ten years. The meteorological data for comparison were taken from the records of the New York station of the United States Weather Bureau and comprise the mean temperature, barometer, and relative humidity, the total movement of the wind, the character of day, and the precipitation for each day of the period covered by the data of conduct.

The latter were as follows, with the sources of each class:[2]

1. Registration in public schools, 118,020 school records.
2. Deportment in public schools, 14,020 school records.
3. Deportment in penitentiary, 3981 penitentiary records.
4. Arrests for assault and battery (males), 36,627 police records.
5. Arrests for assault and battery (females), 3981 police records.
6. Arrests for drunkenness (males), 44,495 police records.
7. Arrests for insanity (males), 2467 police records.
8. Arrests for insanity (females), 1097 police records.
9. Suicide, 2946 police and coroner's records.
10. Deaths, 74,793 board of health records.
11. Policemen off duty for sickness, 191,137 police records.
12. Clerical errors, 3698 bank records.

The whole number of data considered is 497,262.

Of these data, class 1 was studied in order to determine the influence of the less easily recognizable meteorological conditions upon the attendance; class 2 represents the number of pupils who received bad marks for deportment from the registration of class 1; class 3 shows the number of convicts who were in the dark cells in the penitentiary on Randall's Island during the years covered by the study; classes 4, 5, 6, 9, and 10 are sufficiently self-explanatory; classes 7 and 8 are for persons taken to the asylum by the police, for the most part representing initial attacks of insanity or the beginning of recurrent attacks; class 11 covers single days leave of absence by members of the metropolitan police force, and was studied in order to discover, if possible, some fixed relation between the weather and health; class 12 represents the clerical errors made by the employees in several of the larger national banks in the Wall Street district, and was considered in order to determine any concomitance in the fluctuations of weather and mental exactness.

Knowing, then, the exact occurrence of each of these phenomena of conduct for each day of a series of years, and also the exact meteorological condition for each of those days, it was possible by a laborious process of tabulation to determine for which of the latter the former (i. e., the phenomena of conduct) were of normal prevalence, or above or below the normal. Discrepancies between the normal or expectancy curve and that of occurrence of any of the abnormalities of conduct studied were attributed to meteorological influences.

The right to do so is claimed first, since of all conditions the weather is the only one which varies simultaneously for all individuals in a given community, and second, since enough data have been considered to practically eliminate from the results all other influences which bear an accidental relation to the weather.

If, then, in a community of 2,000,000 people we find that regularly for a series of years certain misdemeanors become excessive during the prevalence of particular meteorological conditions, we claim that the relation is one of cause and effect, and this is what we do find.

The number of meteorological conditions studied was 67: For temperature, 19 (each 5° F., from 0° to 95°); for barometer, 15 (each .1 inch, from 29.10 to 30.60 inches); for relative humidity, 14 (each 5 per cent, from 30 to 100 per cent); for wind, 14 (each 50 miles total daily movement, from 50 to 750 miles); for character of the day, 3 (clear, fair, cloudy), and for precipitation, 2 (none and some).

It is not within the scope of this paper to discuss in detail the results of my studies. If one is interested in them, he may find them all, with one exception, in the papers referred to in the footnote. The exception is the study of the New York police which has not been published, since the results were entirely negative. Seemingly, the metropolitan guardians of the peace are immune to weather influence, for in no case did the curve for absence from duty vary from that of expectancy to a greater extent than the mathematically computed probable error.

A single, broad generalization is all I shall hope to make. It is this, that the various meteorological conditions affect directly the metabolic processes of life, some increasing the vital or reserve energy, others tending to its depletion, and that the resulting emotional and intellectual states are those which are common to conditions of excessive or depleted vitality. This conclusion is arrived at on entirely *a posteriori* grounds from a careful study of the discrepancies between expectancy and occurrence curves for the various classes of data studied. It was noted, for instance, that each definite meteorological condition affected the various abnormalities of conduct studied in opposite ways, increasing the frequency of some while retarding that of others. Further inspection showed that it was possible, on the basis of those effects, to divide the data of conduct into two general classes, all those in each class being affected similarly by each of the meteorological conditions. Those which were thus thrown together were: Class A, absences from the public schools, drunkenness, death, and clerical errors. Class B, misdemeanors in the public schools and penitentiary and arrests for assault and battery and insanity. In some respects fluctuations in the occurrence of suicide were analogous to those of class A. Analysis of these various activities or cessations of activity furnishes the ground for my thesis that weather states influence directly the vital energy, since it seems true that all the activities of class B are due to its excess, while those of class A have their origin in its deficiency. To

[1] Author's summary of a memoir read before the American Association for the Advancement of Science, Washington, D. C., January 31, 1903.

[2] Fuller studies discussing these data in detail have been published as follows: Conduct and the Weather; Monograph Supplement, No. 10; The Psychological Review; The Pedagogical Seminary, April, 1898; The Scientific American Supplement, June 3, 1899; Science, August 11, 1899; Appleton's Popular Science Monthly, September, 1899; Educational Review, February, 1900; Nature, February 11, 1900; Annals of American Academy of Political and Social Science, October, 1900; Popular Science Monthly, April, 1901; International Journal of Ethics, July, 1901; Popular Science Monthly, April, 1902; Scientific American Supplement, August 30 and December 13, 1902.

consider the former, in the public schools, sins of commission rather than sins of omission are usually the occasion of bad marks in deportment. It is usually the active, energetic boy, the one with vitality to spare, who gets the demerits. The anemic youngster may never stand at the head of his class, but he is very likely to delight his fond mamma with a mark of 100 in deportment. If that be so, and I speak with authority upon this point if upon no other, disorder in the school room is an active thing, and an evidence of excessive vitality. With the penitentiary inmate I have had less experience, but upon *a priori* grounds would argue that what is true for the child in question of deportment would not be radically different for the adult.

With persons arrested for the crime of assault and battery the same is, I believe, demonstrably true. One might feel like fighting and perhaps more frequently does feel so when possessed of "that tired feeling" which is the fortune of patent medicine venders, but to feel like fighting without doing so, never brought a man before the police judge for the crime which we are considering. There must be both the inclination and the consciousness of strength to back it up before one would be likely to figure in this class of data.

In the case of arrests for insanity, we shall take the word of the psychiatrist that acute mania increases with any condition which tends to augment the output of nervous energy. The daily fluctuations in strength which all have experienced are not so much those of physical as of nervous energy (if this distinction may be made), and with any persons having tendencies to mania the results would be those which our records show.

But to return to those activities of life which vary in an opposite way to those just discussed. In the long run, absence from school is an indication of physical disability. In the case of drunkenness, it seems to me beyond a doubt that with the several classes from which my data were secured the problem of vital energy enters in and that excessive drunkenness is an indication of its depletion. We may, I believe, with justice conclude that many of the habitués of the police court as prisoners struggle against their tendencies to drink, knowing the consequences. When vitality is excessive they do so with success, for days and perhaps for weeks they are winners, but finally the time comes when the fight is too severe and they succumb. That was the day when vitality was at its lowest ebb.

If, then, this general analysis be a correct one, the various meteorological conditions produce a direct result upon the metabolic processes of life, some of them tending to accelerate the production of vital energy, others to retard the process. For the want of better terms, though fully recognizing the inexactness of their application, I shall use the term anabolic as indicative of the former, katabolic the latter.

To consider very briefly the exact effects of the various meteorological conditions. Low temperatures seem generally katabolic, with gradually increasing anabolic tendency until a mean temperature of about 85° F. is reached, when a sudden change takes place and the effect upon available energy is disastrous. At this point active disorder reaches its minimum, while the death rate, suicide, and clerical error increase to an alarming extent. Low barometric pressure is anabolic in its effect, with the reverse for a higher mercurial column. As to conditions of relative humidity, a dry atmosphere is uniformly exhilarating (anabolic), while a moist one is correspondingly depressing. For no other one of the meteorological conditions is the effect so marked. A study which I made of the deportment of children in the public schools of Denver, Colo., where the prevailing condition is one of low humidity, but where occasionally atmospheric moisture reaches almost to the zero point, demonstrated that upon such successively dry days active disorder ran up to more than seven times the normal. For conditions of wind, strangely enough, calms are found to have a katabolic effect of tremendous magnitude in New York City. During their prevalence the death rate is abnormally high, and there are three times the normal number of absentees among the school children. At the same time the police courts practically go out of business. It seems probable to me that these conditions are practically the results of poor ventilation on a large scale.

For days of different character, as determined by the sunshine recorder and also by precipitation, we find influences such as would most naturally be expected; i. e., anabolic for the clear and dry, with the opposite for those of the other character. Deportment, however considered, is at its best on the cloudy, wet days, while the death rate is high. Suicide, however, here shows a peculiar anomaly in that it is excessive on the bright, dry days.

Some interesting facts not already alluded to are suggested by my studies, and in conclusion I mention two of them:

First. There would seem to be reason to infer that the influence of the state of the weather upon children is more marked than that upon adults.

Second. That women seem to be more sensitive to such influence than men. Evidences of this are to be found in the study of arrests for assault and battery, where the sexes were tabulated separately.

In explanation of my own conception of the whole problem of weather influences, I would say, in closing, that we can not suppose peculiar meteorological conditions to be the immediate cause of many of the abnormalities of conduct which vary with them. I have determined that suicide is much more frequent when the barometer is low than when it is high, yet would not wish to assert that low barometrical conditions ever drove a man to self-destruction. The only thing supposable is that during such atmospheric conditions the general emotional states are of such qualities that other things are more likely to do so.

This would be just as true for any of the other abnormalities of conduct studied. We can, on the strength of the whole series of studies, claim to have demonstrated that the metabolic processes of life to some extent vary with the weather states and that these variations in metabolism make themselves evident both through physiological and psychological manifestations. More than this we do not at present claim.

ELASTICITY AT LOW TEMPERATURES.

By J. R. BENTON, Ph. D. (Göttingen, 1900), dated Washington, D. C., February 20, 1903.

The subject of elasticity of solids has perhaps a less direct interest for the meteorologist than some other branches of science; it must, however, claim some attention on account of the use of numerous meteorological instruments whose action depends on the elasticity of springs. It is important to know how the indications of Vidi aneroids and Bourdon pressure gages, of air thermometers, and of pressure anemometers are affected by changes of temperature producing changes in the elasticity of important parts of these instruments. Since in making observations at great altitudes, the meteorographs are exposed to very low temperatures, it is desirable, in particular, to know how elasticity is influenced by extreme cold.

But few general statements can be made in regard to the variation of elasticity with temperature. In almost all substances the elasticity decreases with rising temperature; yet this general rule has an exception in the case of vulcanized india rubber, which, under certain conditions, becomes more elastic as its temperature increases. It is a general rule, also, though not a universal one, that the rate of change of elasticity with temperature, for a given substance, is greater as the temperature is higher. Comparing different substances,